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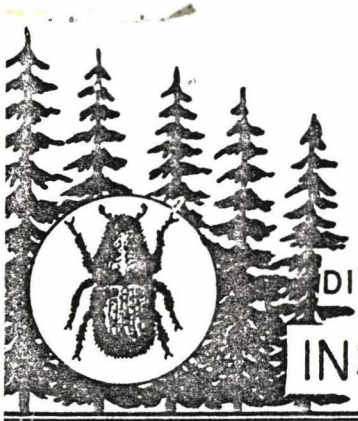

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DIVISION OF STATE AND PRIVATE FORESTRY

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EVALUATION OF DOUGLAS-FIR BEETLE INFESTATIONS IN THE NORTH FORK CLEARWATER RIVER DRAINAGE, IDAHO--1971

By

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ABSTRACT

A massive Douglas-fir beetle, Dendroctonus pseudotsugae Hopk., infestation encompassing a gross area of 288,000 acres was detected in the North Fork Clearwater River drainage in northern Idaho. A cooperative aerial photo-ground survey revealed that an estimated 174,164 trees were killed during the 2-year period 1970-71, resulting in a loss of 85,835 MBF of Douglas-fir sawtimber. Infestation levels are expected to decline in 1972, but losses will still be significant.

INTRODUCTION

The Douglas-fir beetle, Dendroctonus pseudotsugae Hopk., is a serious insect pest of Douglas-fir, Pseudotsuga menziesii var. glauca (Mirb.) Franco, the most valued commercial tree species in the Northern Region. This insect periodically reaches epidemic levels, usually following a natural disaster such as severe windstorms or ice storms which provide

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large volumes of breeding material in the form of damaged timber. Beetles normally invade this material, reach epidemic proportions, and attack standing green trees the following year (Furniss and Orr 1970).[4/]

A massive infestation of the Douglas-fir beetle was discovered in Douglas-fir forests of the North Fork Clearwater River drainage in northern Idaho during 1971. Aerial reconnaissance surveys conducted by the Clearwater-Potlatch Timber Protective Association established the infestation boundaries to be the lower North Fork from Dworshak Dam to the Canyon Ranger Station of the Clearwater National Forest, with heavy concentrations of beetle activity occurring in Meadow and O'Neill Creek drainages and on the slopes of John Lewis Mountain. The infestation apparently reached epidemic proportions in 1970 but was not detected until a year later when infested trees began to fade.

Factors which may have contributed to a buildup of Douglas-fir beetle populations in the area are believed to be:

1. Ice and snow breakage that occurred in Douglas-fir stands during the winter of 1968-1969, which provided an abundance of breeding material.
2. Land-clearing activities associated with the construction of Dworshak Dam on the North Fork Clearwater River which resulted in considerable volumes of green Douglas-fir slash.
3. Extensive stands of Douglas-fir in the North Fork Clearwater River drainage which are susceptible to Douglas-fir beetle attack.

An evaluation of this infestation, using aerial photographic and ground survey methods, was conducted during August 1971. This evaluation was a cooperative effort involving forest land managers from the Idaho Department of Public Lands, Potlatch Forests, Inc., Clearwater-Potlatch Timber Protective Association, Corps of Engineers, Bureau of Land Management, Intermountain Forest and Range Experiment Station, Clearwater National Forest, and entomologists from the Division of State and Private Forestry.

SURVEY METHODS

Impact survey.--Double sampling with regression was used to estimate:

1. The number of trees killed by Douglas-fir beetle in 1970.
2. The volume loss caused by Douglas-fir beetle in 1970.
3. The number of trees killed by Douglas-fir beetle in 1971.
4. The volume loss caused by Douglas-fir beetle in 1971.

This consisted of a large aerial photo sample corrected by a small ground sample (Wear, et al. 1966).

4/ Names and date in parentheses refer to list of references cited at the end of report.

A series of one hundred 100-acre aerial photo plots was established in a systematic grid pattern over the 288,000-acre area of infestation. Photo missions were flown in mid-August at a scale of 1:7920 (8 inches = 1 mile) by the Division of Engineering, U.S. Forest Service, Missoula, Montana. Film-filter combination was Ektachrome infrared Aero (type 8443) with a Wratten G filter. A 9-inch format Ziess-RMK/A aerial camera equipped with a 6-inch focal length lens was used for the photography. Stereo pairs (60 percent overlap) were taken at each plot location.

One hundred-acre photo plots, 20 by 50 chains, were located within the stereo overlap portion of each photo pair. These plots were examined stereoscopically with an Old Delph scanning stereoscope by two photo interpreters (PI) working independently. Each photo interpreter made a detailed count of the number of Douglas-fir with discolored crowns in the plots. Care was taken to separate western white pines, Pinus monticola, killed by either white pine blister rust, Cronartium ribicola, or mountain pine beetle, D. ponderosae Hopk., and grand fir, Abies grandis, killed by fir engraver, Scolytus ventralis Lec., from trees killed by Douglas-fir beetle. Criteria used for separating discolored Douglas-fir crowns from discolored crowns of other tree species was the crown form of the host trees; Douglas-fir is a full-crowned species whereas both western white pine and grand fir have considerably narrower crowns. In addition, Douglas-fir beetle infestations generally occur as group kills as opposed to the other insect and disease agents common to the area which occurred more often as scattered single-tree attacks.

Twenty-six of the 100 photo plots were randomly selected for ground sampling. A variable plot cruise was conducted in each of these plots using a relaskop (BA = 20). Subplots were established at 5-chain intervals on cruise lines 5 chains apart for a total of 40 subplots per photo plot. Each tree occurring in a subplot was recorded by species, d.b.h., and total height, and was classified into one of four tree classes:

0 -green, uninfested
1 -attacked in 1971; green foliage, brood in cambium
2 -attacked in 1970; faded or red foliage, brood emerged
3 -snags, attacked prior to 1970

Resultant data was analyzed by a modified ADP sale cruise program which provided summaries of infestation levels, volume losses by year, and residual stand composition for each plot ground cruised. Four variables--1970 trees, 1970 volumes, 1971 trees, and 1971 volumes--were used as the dependent variable "y" and the photo count of discolored trees was the independent variable "x" in the regression analysis.

Brood sampling.--Four groups of infested trees were selected for brood sampling. These were located in Upper Meadow Creek, Bartlett Point, Little Silver Creek, and John Lewis Mountain. The number of attacked trees in each group was determined. The attacked trees were stratified into two categories: (1) successful attacks, containing brood, and (2) unsuccessful attacks, lacking brood. Bark samples were obtained from 10 to 20 successfully attacked trees per group. Two bark samples were removed from each sample tree using a one-tenth square foot bark punch (Furniss, 1962) at a point 9 to 15 feet on the bole. The number of gallery starts and overwintering brood was obtained for each bark sample. These samples were obtained in September and October, 1971.

RESULTS

Infestation levels.--Air currents occurring over the survey area at the time of the photo mission caused the survey aircraft to drift from time to time. This altered the pattern of aerial photo plots from a systematic grid to a quasi-random configuration (Fig. 1). Color patterns of discolored crowns due to Douglas-fir beetle infestation on Ektachrome infrared Aero film were comparable to those described for southern pine beetle Dendroctonus frontalis Zimm., in the southeastern United States (Ciesla, et al. 1967). Red-topped and fading Douglas-fir appeared as a yellow to beige color and older kills, which had lost their needles, registered as blue-green to gray.

Summaries of photo interpretations by the two independent interpreters were quite similar (Table 1). Both sets of "PI" data were collected with ground survey data (Table 2) in order to obtain F ratios for slope and the correlation coefficient "r". The F ratios of the regressions were significant at the 99 percent level for all four dependent variables for one PI and significant at the 99 percent level for three of the four dependent variables for the second PI. The F ratio for the regression of 1971 volume loss over 1970 attacks was significant at the 95 percent level for the second PI (Table 3). Correlation coefficients (r) were high (over 0.80) for three of the four dependent variables for both photo interpreters (Table 3) with relatively poor correlation occurring for the regression of 1971 volume loss over 1970 attacks (0.512 and 0.494). F ratios and correlation coefficients were slightly higher for one PI; therefore, this data was used to prepare estimates of tree and volume losses (Table 3)(Fig. 2).

Aerial photo estimates corrected by ground surveys indicated that a mean infestation level of 0.2379 Douglas-fir per acre resulting in a volume loss of 123.75 board feet per acre occurred in 1970. In 1971, infestation levels increased to 0.3684 trees per acre with a resultant volume loss of an additional 177.75 board feet per acre. Total loss for the 288,000-acre survey area is estimated at 68,515 trees and 34,640,000 board feet in 1970 and 106,099 trees and 51,195,000 board feet in 1971. The ratio of 1970 to 1971 attacks was 1:1.5; however, the size of tree attacked was somewhat smaller in 1971 than in 1970 (Table 4).

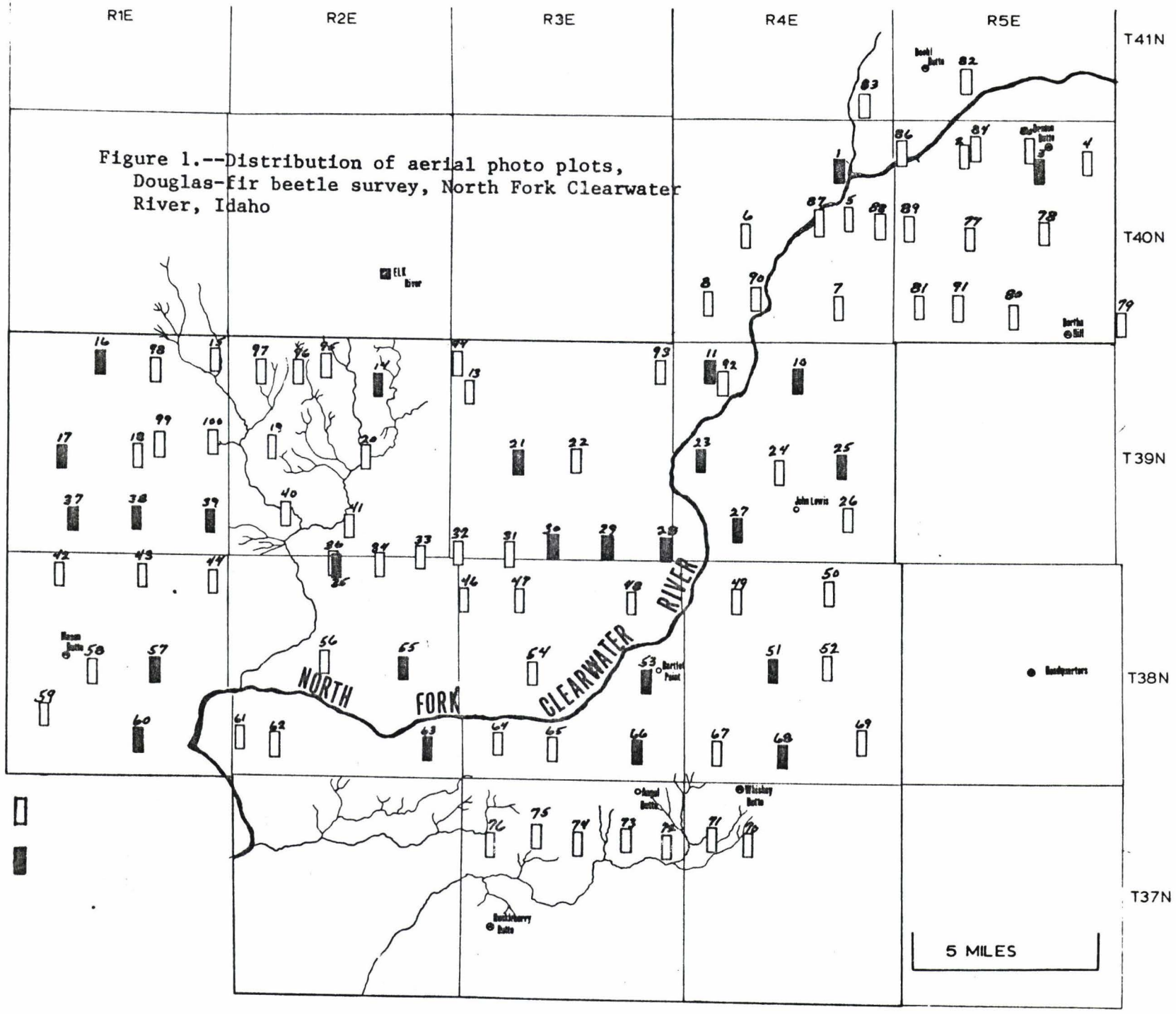

Figure 1.--Distribution of aerial photo plots, Douglas-fir beetle survey, North Fork Clearwater River, Idaho

Table 1.--Summary of photo interpretations Douglas-fir beetle survey, North Fork Clearwater River, Idaho.

Plot	No. trees PI-1 WMC	No. trees PI-2 WEB	Plot	No. trees PI-1 WMC	No. trees PI-2 WEB	Plot	No. trees PI-1 WMC	No. trees PI-2 WEB
1	1	5	35	5	5	69	5	0
2	3	0	36	8	12	70	12	13
3	1	5	37	0	0	71	0	0
4	0	0	38	0	0	72	0	0
5	15	6	39	0	0	73	0	0
6	24	26	40	38	32	74	5	4
7	39	40	41	21	12	75	24	26
8	5	0	42	0	0	76	0	0
9	5	0	43	0	0	77	0	2
10	30	24	44	0	0	78	5	5
11	9	9	45	0	0	79	0	0
12	11	0	46	0	0	80	0	0
13	6	2	47	0	0	81	0	0
14	20	15	48	0	0	82	4	3
15	0	0	49	0	0	83	1	3
16	2	0	50	0	0	84	11	3
17	1	7	51	0	0	85	4	0
18	1	3	52	9	7	86	13	17
19	33	44	53	15	12	87	0	2
20	31	24	54	13	10	88	17	11
21	1	0	55	0	0	89	1	3
22	50	43	56	0	0	90	4	6
23	0	11	57	0	1	91	0	0
24	103	58	58	3	0	92	11	11
25	0	11	59	0	0	93	0	0
26	15	9	60	0	1	94	0	0
27	217	137	61	4	5	95	0	4
28	4	18	62	0	0	96	2	4
29	25	22	63	7	7	97	1	0
30	0	0	64	13	8	98	0	10
31	0	0	65	11	6	99	0	0
32	2	0	66	22	32	100	32	29
33	0	0	67	8	9			
34	0	0	68	4	4			

Table 2.--Summary of ground data Douglas-fir beetle survey, North Fork Clearwater River, Idaho.

Plot	Photo count (X) PI-1 WMC	Photo count (X) PI-2 WEB	Ground count (Y) 1970 trees	Ground count (Y) 1970 vol. (bd. ft.)	Ground count (Y) 1971 trees	Ground count (Y) 1971 vol. (bd. ft.)
3	1	5	0	0	23	7,510
10	30	24	33	18,292	69	34,799
11	9	9	72	13,699	0	0
12	11	0	15	11,906	0	0
14	20	15	0	0	28	36,776
16	2	0	0	0	0	0
17	1	7	0	0	0	0
21	1	0	0	0	0	0
23	0	11	36	7,508	100	12,537
25	0	11	0	0	0	0
27	217	137	258	164,257	322	81,440
28	4	18	0	0	0	0
29	25	22	79	44,163	123	52,600
30	0	0	0	0	0	0
35	5	5	84	37,628	54	29,723
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	0
51	0	0	22	9,406	18	6,804
53	15	12	160	60,252	172	131,121
55	0	0	0	0	0	0
57	0	1	0	0	0	0
60	0	1	0	0	0	0
63	7	7	0	0	11	12,340
66	22	32	59	44,002	166	34,174
68	4	4	0	0	48	68,412

Table 3.--Regression equations for predicting numbers of infested trees and volume losses - Douglas-fir beetle survey North Fork Clearwater River, Idaho.

PI	Y	Regression equations (Y = MX + b)	F ratio for slope	Correlation coefficient (r)
WMC	1970 Trees	Y = 1.167 x + 14.675	45.597*	.815
	1970 Volume	Y = 761.301 x + 4626.77	144.792*	.926
	1971 Trees	Y = 1.499 x + 21.58	50.72 *	.824
	1971 Volume	Y = 392.921 x + 13759.5	8.51 *	.512
WEB	1970 Trees	Y = 1.829 x + 8.884	46.720*	.813
	1970 Volume	Y = 1182.13 x + 1217.33	122.016*	.914
	1971 Trees	Y = 2.436 x + 13.538	62.8115*	.851
	1971 Volume	Y = 596.377 x + 12184.6	7.737**	.494

* Significant at 99% level for 1 and 24 d.f. where F = 7.82.

** Significant at 95% level for 1 and 24 d.f. where F = 4.26.

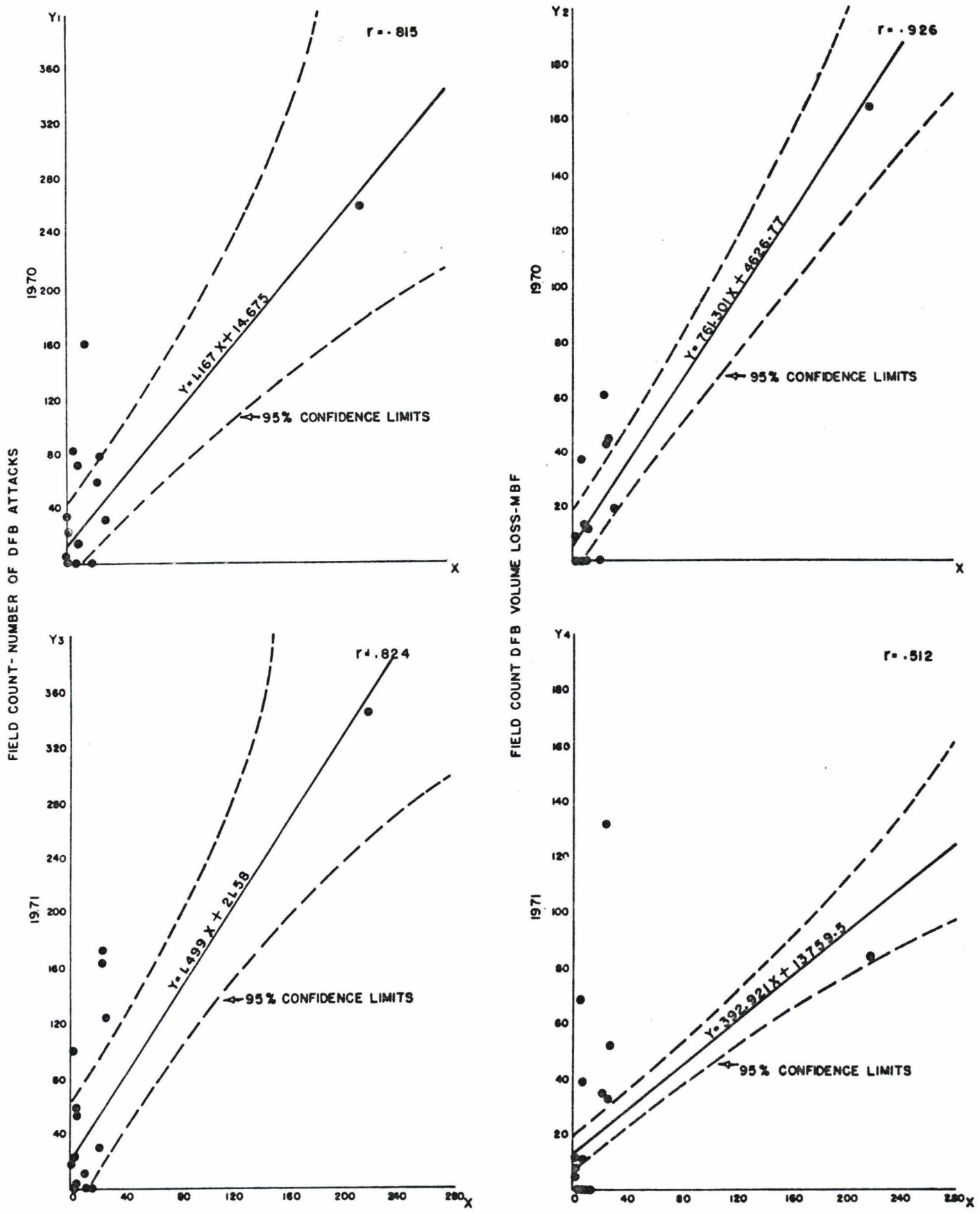

Figure 2.--Linear regression of field counts over photo counts.

Table 4.--Estimated losses by Douglas-fir beetle
North Fork Clearwater River - 1970-71.

	1970	1971	Total
Trees/Acre	.2379 ± .086[1/]	.3684 ± .108	.6063
Volume/Acre (bd. ft.)	123.75 ± 40.94	177.75 ± 35.38	301.50
Total trees[2/]	68,515 ± 24,734	106,099 ± 31,087	174,614
Total volume[2/] (MBF)	34,640 ± 10,465	51,195 ± 10,290	85,835
Volume/infested tree (bd. ft.)	520	482.5	491.6

1/ 1 S.E.

2/ Based on a gross area of 288 M acres in the survey unit.

Impact on green stand.--Ground surveys provided data on the structure of the total stand in the North Fork Clearwater River drainage. The large volume of data collected on these surveys exceeded the capacity of the program; consequently, the data is summarized in two groups of 13 ground plots each: plots 3-29 and 30-68 (Tables 5 and 6). The drainage contains a great variety of commercial tree species with Douglas-fir following grand fir and western redcedar, Thuja plicata Donn., in order of abundance. The stands are heavily stocked with Douglas-fir making up 12.1 percent of the total stand volume in plots 3 through 29 and 21.9 percent in plots 30 through 68.

The Douglas-fir beetle destroyed 10.5 percent of the host volume and 1.2 percent of the total stand volume in plots 3 through 29 over the 2-year period, 1970 and 1971, and 7.9 percent of the host volume and 1.7 percent of the total stand volume in plots 30 through 68. These figures indicate a rather low impact of Douglas-fir beetle on the total stand; however, they may be somewhat misleading because Douglas-fir beetle attacks are generally concentrated in groups. The impact of this insect on a single infested stand is considerably higher than on the overall survey area.

Ground survey data clearly illustrates the insect's preference for trees in the larger diameter classes. In plots 3 through 29, for example, the average d.b.h. of a tree attacked by Douglas-fir beetle was 20 inches in 1970 and 16 inches in 1971. By contrast, the average d.b.h. of the green Douglas-fir stand in these plots was 9 inches. A similar relationship exists for plots 30 through 68.

Biological data.--Data collected from sample trees indicates than 31 percent of the trees attacked by Douglas-fir beetle in 1971 were unsuccessful and did not contain brood (Table 7). Trees that were attacked unsuccessfully were somewhat smaller in diameter than were trees that were killed.

Over half of the trees with successful attacks contained a brood/parent ratio of less than 1.0 and are considered to be population "sinks." Thirty-five percent contained a brood/parent ratio of more than 1.0 (population "generators"), and the remainder had a static ratio (=1.0). The overall brood/parent ratio averaged 1.2. Nine percent of the brood were larvae, 5 percent were pupae, and 86 percent were callow adults. The larvae will mature and emerge later than the adults and probably fill in already attacked trees, thus slightly lowering the effective brood/parent ratio.

Table 5.--Summary of ground survey data, plots 3-29, North Fork Clearwater River Douglas-fir beetle survey--1971.

Tree class	Species	Trees /acre	Volume/ acre (bd. ft.)	Mean d.b.h.	Mean height
Green	Cedar	28.8	3,695	11	52
	Grand fir	114.4	19,282	9	53
	Subalpine fir	.1	11	15	80
	Western larch	2.3	845	17	104
	Engelmann spruce	3.2	324	10	48
	Lodgepole pine	.8	93	12	58
	W. white pine	3.7	2,170	17	105
	Ponderosa pine	.5	420	20	101
	Douglas-fir	27.6	3,310	9	57
	W. hemlock	.1	28	21	109
	TOTAL GREEN	181.5	30,178		
1971 attack	Douglas-fir	.5	174	16	117
1970 attack	Douglas-fir	.4	200	20	121
	TOTAL	182.4	30,552		

Table 6.--Summary of ground survey data plots 30-68, North Fork Clearwater River Douglas-fir beetle survey, Idaho.--1971.

Tree class	Species	Trees /acre	Volume/ acre (bd. ft.)	Mean d.b.h.	Mean height
Green	Cedar	109.1	3,875	5	30
	Grand fir	214.7	8,724	4	27
	Subalpine fir	.9	21	6	33
	Western larch	14.4	1,320	9	65
	Engelmann spruce	.2	10	7	35
	Lodgepole pine	.1	9	9	53
	W. white pine	1.9	407	11	78
	Ponderosa pine	.7	621	18	73
	Douglas-fir	54.0	3,872	8	49
	TOTAL GREEN	396.0	18,859		
1971 attack	Douglas-fir	.4	217	21	110
1970 attack	Douglas-fir	.3	116	21	113
	TOTAL	396.7	19,192		

Table 7.--Summary of Douglas-fir beetle brood data
North Fork Clearwater River, Idaho.--1971

Sample location	Stand age		Percent unsuccessful attacks	Successful attacks[1/]			Brood parent ratio
	Mean	Range		Increase percent	Static percent	Decrease percent	
Upper Meadow Creek	106	81-120	26	41	18	41	1.4
Bartlett Point	90	72-135	39	35	0	65	1.1
Little Silver Creek	88	71-101	26	30	20	50	.8
John Lewis		90-175	-	-	-	-	1.3
TOTAL OR AVERAGE			31	35	13	52	1.2

1/ Classified into groups by their brood/parent ratios.

DISCUSSION AND CONCLUSIONS

Douglas-fir beetle infestations in the North Fork Clearwater River have been extremely heavy during the past 2 years with an estimated total loss of 85,835 MBF of Douglas-fir sawtimber.

Infestation levels are expected to decline in 1972. This prediction is based on the fact that the current brood/parent ratio was only 1.2 in early fall. Additional brood mortality during winter, plus dispersal losses and pitch-out mortality during the flight period next spring should lower the brood/parent ratio to at least 0.7, thus resulting in fewer attacks in 1972. In addition, a strong trend toward attacking smaller trees was observed when comparing 1970 and 1971 attack data (Tables 4, 5, and 6). This may indicate that the insect is running out of suitable host material (large, old growth Douglas-fir) and is invading less favorable material. If this is the case, the proportions of unsuccessful attacks should increase in 1972.

Although 30 percent decrease in successful attacks is indicated, this could still result in an additional 30 to 35 MMBF loss due to the beetle in the North Fork Clearwater River drainage in 1972. This should be countered with an aggressive salvage effort to recover as much loss as possible.

Pheromones of the beetle--including the anti-attractant, methylcyclohexenone--will be tested by research but are not yet developed for use in suppression.

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